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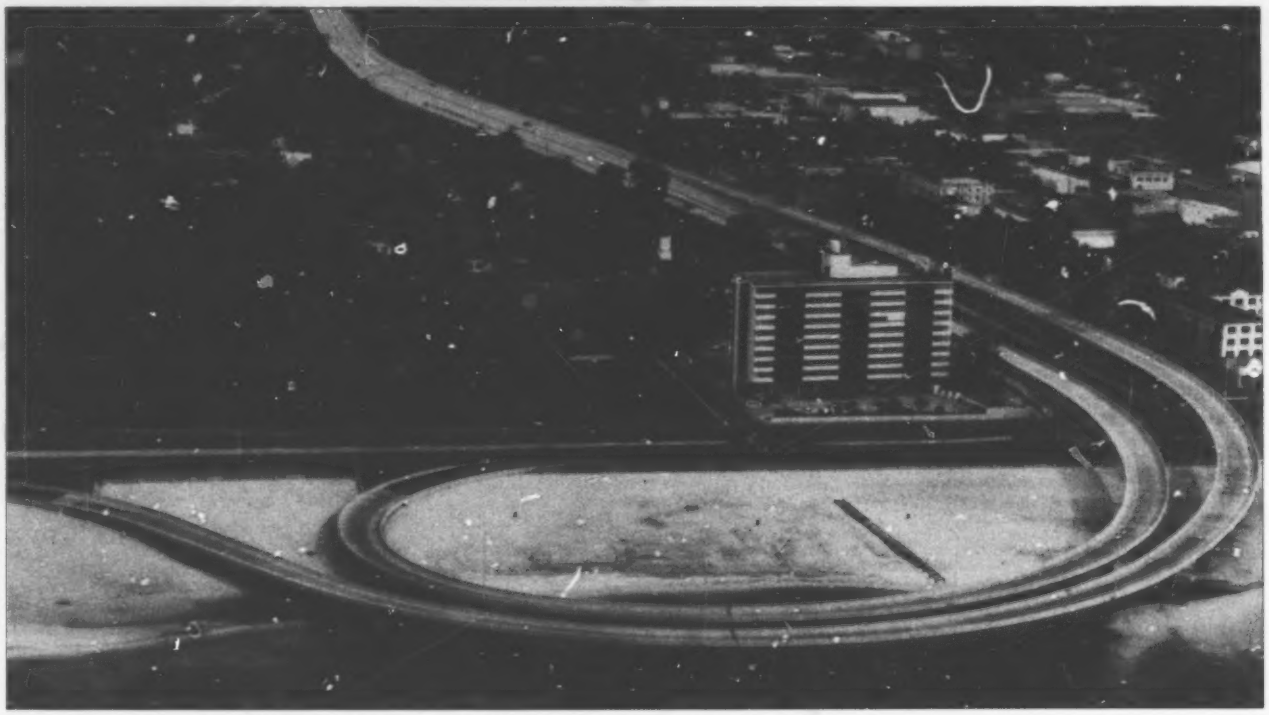

CEMENT

By Wilton Johnson

1989

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

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CEMENT

U.S.
DEPARTMENT
OF THE
INTERIOR

Manuel Lujan, Jr.
Secretary

BUREAU
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MINES

T S Ary
Director

October 1990

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COVER PHOTO:
Aerial view of the completed segment of I-110, Biloxi, MI, with four traffic lanes and shoulders for a typical width of 81 feet, 10 inches and spans of 130 feet long. Cement is an important ingredient of concrete that is used in a variety of construction structures, including buildings, highways, and bridges. (Photo is courtesy of Figg and Muller Engineers Inc.)

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CEMENT

By Wilton Johnson

Mr. Johnson, a minerals industry specialist with 28 years of industry and Bureau of Mines experience, has been the commodity specialist for cement since 1983. Domestic survey data were prepared by Howard L. Sullivan, mineral data assistant; and international survey data were prepared by Audrey D. Wilkes, international data assistant.

U.S. demand for cement declined slightly for the second year following five consecutive years of growth. Housing starts declined 8%, and the value of new construction put in place also declined slightly. Cement shipments increased to four of the nine Census regions. California continued to lead all States in the amount of cement consumed.

Domestic cement production increased slightly for the first time following two consecutive years of decline. Shipment of domestically produced cement from domestic mills increased slightly, while the amount of imported cement shipped by producers declined 23%. Total imports declined for the second year, making up 17% of apparent consumption compared with 19% experienced in the record year of 1987.

Cement prices increased for the first time in 6 years, reaching their highest level since 1985.

DOMESTIC DATA COVERAGE

Domestic production and consumption data for cement are developed by means of the portland and masonry cement voluntary survey. Of the 127 cement manufacturing plants to which an annual survey collection request was made, 125 responded, representing 98.4% of the cement production and consumption data shown in table 1. Estimates were made for nonrespondents using monthly survey data and data received from previous annual surveys.

ISSUES

The primary issue facing the cement industry is a lack of capital investment for new plant construction or capacity modernization and expansion. Foreign import penetration into coastal markets and regional competition among domestic producers have combined to reduce the profitability of the U.S. industry. The lack of domestic investment capital has opened the door for foreign investors who now own more than two-thirds of U.S. cement production capacity.

PRODUCTION

One State agency and 49 companies operated 127 plants in 39 States. In addition, two companies operated two plants in Puerto Rico, manufacturing hydraulic cement. The production data obtained are arranged by State or groups of States that form cement districts. A cement district may represent a group of States or a portion of a State. The States of California, Illinois, New York, Pennsylvania, and Texas are divided to provide more definitive marketing information within those States as follows:

California, Northern.—Points north and west of the northern borders of San Luis Obispo and Kern Counties and the western borders of Inyo and Mono Counties.

California, Southern.—All other counties in California.

Chicago, Metropolitan.—The seven Illinois counties of Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will.

Illinois.—All other counties in Illinois.

New York, Western.—All counties west of a dividing line following the

TABLE 1

SALIENT CEMENT STATISTICS

(Thousand short tons unless otherwise specified)

	1985	1986	1987	1988	1989
United States:[1]					
Production[2]	77,895	78,786	78,198	76,867	77,189
Shipments from mills[2 3]	83,032	87,592	r89,246	r89,460	86,238
Value[2 3 4] thousands	$4,286,399	$4,407,722	$4,393,684	$4,370,463	$4,242,931
Average value per ton[2 3 4]	$51.61	$50.32	r49.23	r48.85	$49.20
Stocks at mills,[2] Dec. 31	7,232	6,725	6,159	5,997	6,300
Exports	98	59	52	101	512
Imports for consumption	14,120	r16,091	17,536	r17,298	15,548
Consumption, apparent[5 6]	87,456	91,501	93,886	93,256	90,676
World: Production	r1,057,794	r1,106,182	1,153,425	p1,215,498	e1,235,613

e Estimated. p Preliminary. r Revised.

[1] Excludes Puerto Rico and the Virgin Islands.

[2] Portland and masonry cement only.

[3] Includes imported cement shipped by domestic producers.

[4] Value received, f.o.b. mill, excluding cost of containers.

[5] Quantity shipped plus imports minus exports.

[6] Adjusted to eliminate duplication of imported clinker and cement shipped by domestic cement manufacturers.

eastern boundaries of Broome, Chenango, Lewis, Madison, Oneida, and St. Lawrence Counties.

New York, Eastern.—All counties east of the above dividing line, except Metropolitan New York.

New York Metropolitan.—The five counties of New York City (Bronx, Kings, New York, Queens, and Richmond) plus Nassau, Rockland, Suffolk, and Westchester Counties.

Pennsylvania, Eastern.—All counties east of the eastern boundaries of Centre, Clinton, Potter, Franklin, Huntingdon, and Potter Counties.

Pennsylvania, Western.—All other counties in Pennsylvania.

Texas, Northern.—All counties north of a dividing line following the northern borders of Burnet, Crockett, Jasper, Jeff Davis, Llano, Madison, Mason, Menard, Milam, Newton, Pecos, Polk, Robertson, San Jacinto, Schleicher, Tyler, Walker, and Williamson Counties.

Texas, Southern.—All counties south of the above dividing line.

Clinker Production

Clinker production in the United States, excluding Puerto Rico, was essentially the same at 69.3 million tons. California continued to lead all States in clinker production, accounting for approximately 14% of the total. More than two-thirds of the clinker came from eight plants in the southern part of the State. Texas followed with about 10% of total production. Pennsylvania ranked third, with most of the clinker produced at plants in the eastern part of the State, followed by Michigan and Missouri. Together these five States accounted for 46% of total U.S. clinker production.

By yearend, multiplant operations were being run by 25 companies. The size of individual companies, as a percentage of total U.S. clinker production capacity, ranged from 0.3% to 6%. The 5 largest producers provided 29% of total clinker production; the 10 largest producers provided a combined 50%. The 10 largest companies, in decreasing order of size of clinker production, were Lafarge Corp., Southdown Inc., Lone Star Industries Inc., Lehigh Portland Cement Co., Ideal Basic Industries Inc., Dundee Cement Co., Blue Circle Inc., Ash Grove Cement Co., Gifford-Hill and Co., and CalMat Co.

Portland Cement

Portland cement production increased slightly to 73.9 million tons. This was the first production increase following two consecutive years of decline. The increase was attributed to less reliance on imports of finished cement to satisfy demand primarily in Eastern markets. The closing of plants in Alabama, Texas, Utah, and Washington reduced operating capacity slightly to 98.1 million tons. The capacity utilization rate increased to 75.3%.

The industry operated 122 plants, including 8 grinding facilities to produce various types of finished hydraulic cement, compared with 126 plants in 1988. California continued to lead all States with 15% of production, followed by Texas with 10%, Michigan with 7%, and Pennsylvania East and Missouri with 6% each. Together these five States accounted for 44% of total U.S. cement production.

The size of individual companies, as a percentage of total U.S. finished cement production capacity, ranged from 0.01% to 7.0%. The top 10 producing companies, in declining order of production, were Lafarge Corp., Southdown Inc., Lone Star Industries Inc., Lehigh Portland Cement Co., Ideal Basic Industries Inc., Dundee Cement Co., Ash Grove Cement Co., Gifford-Hill and Co., Blue Circle Inc., and CalMat Co.

Masonry Cement

Production of masonry cement declined 8% to 3.3 million tons. At yearend, 81 plants were manufacturing masonry cement in the United States. Two plants producing masonry exclusively were Chaney Lime & Cement Co., Algood, AL, and Riverton Corp., Riverton, VA.

Aluminous Cement

Aluminous cement continued to be produced by Lehigh, Buffington, IN; Lone Star Lafarge, Chesapeake, VA; and Aluminum Co. of America, Bauxite, AR.

Fuel Consumption

The industry's energy efficiency for production of clinker and finished cement continued to improve. Average energy consumption per ton of clinker produced was 3.8 million British thermal units (Btu), slightly lower than that required in 1988. The consumption of electrical energy remained at the equivalent of 1.1 million Btu per ton. Average fuel consumption for kiln for firing plus electricity for grinding was 4.9 million Btu per ton. Fuel used in wet-process plants was 4.5 million Btu per ton, 36% higher than the dry process of 3.3 million Btu per ton. Approximately 67% of clinker was produced by the dry process method. The industry reported 67 suspension and 10 grate preheaters in use during the year. Kilns without preheaters averaged 4.5 million Btu per ton, those with suspension preheaters averaged 3.3 million Btu per ton, and those with grate-type preheaters averaged 4.9 million Btu per ton. Coal accounted for 93% of kiln fuel consumption, natural gas accounted for 4%, and oil and waste fuel accounted for the remainder.

Corporate Changes

Dundee Cement Co., a subsidiary of Holderbank Financiere Glaris SA, purchased the Mason City, IA, cement plant of Northwestern States Portland Cement Co. Ideal Basic Industries, also a subsidiary of Holderbank, acquired Allied Cement Co.'s Birmingham, AL, plant and began using it as a distribution terminal. National Portland Cement Co. of Florida sold its remaining 59% interests to a group of Spanish producers: Cementos Molins, S.A.; Uniland Cementera, S.A.; and Asland S.A. The group initially purchased 41% interest in National in 1988. Lafarge Corp. acquired controlling interest in the Swiss firm Cementia Holdings S.A. Cementia owns two U.S. cement plants—Davenport Cement Co. in Buffalo, IA, and Missouri Portland Cement Co. in Sugar Creek, MO. Riverside Cement Co., a subsidiary of Gifford-Hill and Co., formed a joint venture with the Republic of Korea's Ssangong Cement Industrial Co. to operate a bulk storage facility at the port of Stockton in Northern California. Ash Grove Cement Co. purchased the Leamington, UT, cement plant from Martin Marietta.

TABLE 2

PORTLAND CEMENT PRODUCTION, CAPACITY, AND STOCKS IN THE UNITED STATES, BY DISTRICT[1]

District	1988					1989				
	Plants active during year	Production[2] (thousand short tons)	Capacity[3]		Stocks[4] at mills, Dec. 31 (thousand short tons)	Plants active during year	Production[2] (thousand short tons)	Capacity[3]		Stocks[4] at mills, Dec. 31 (thousand short tons)
			Finish grinding (thousand short tons)	Percent utilized				Finish grinding (thousand short tons)	Percent utilized	
New York and Maine	5	3,459	4,265	81.1	310	5	2,980	4,265	69.8	308
Pennsylvania, eastern	8	4,840	5,821	83.1	308	8	4,492	5,771	77.8	435
Pennsylvania, western	4	1,523	2,417	63.0	169	4	1,513	2,417	62.5	176
Maryland	3	1,824	2,030	89.8	143	3	1,884	2,030	92.8	185
Ohio	4	1,495	2,200	67.9	147	4	1,449	2,200	65.8	153
Michigan	5	5,127	6,090	84.1	348	5	5,266	6,090	86.4	335
Indiana	4	2,629	3,140	83.7	188	4	2,469	3,140	78.6	224
Illinois	4	2,033	2,580	78.7	196	4	2,700	2,750	98.2	283
Georgia and Tennessee	4	2,273	2,595	87.5	180	4	1,987	2,595	76.5	192
South Carolina	3	2,482	3,440	72.1	117	3	2,270	3,306	68.6	140
Kentucky, Virginia, West Virginia	3	2,351	3,052	77.0	143	3	2,277	3,132	72.7	227
Florida	6	3,349	4,761	70.3	229	6	3,804	4,660	81.6	290
Nebraska and Wisconsin	1	W	W	W	W	1	W	W	W	W
Alabama	6	3,806	5,326	71.4	235	5	3,411	5,276	65.9	302
Arkansas, Louisiana, Mississippi	3	1,385	2,040	67.8	133	3	1,191	2,200	54.1	75
Utah	3	778	1,365	56.9	63	2	W	W	W	W
South Dakota	1	577	1,800	32.0	58	1	W	W	W	W
Iowa	4	2,006	2,725	73.6	219	4	2,230	2,725	81.8	323
Missouri	5	4,460	4,780	93.3	332	5	4,418	4,780	92.4	287
Kansas	5	1,607	2,460	65.3	206	5	1,544	2,425	63.6	208
Oklahoma	3	1,579	2,048	77.0	218	3	1,526	2,048	74.5	217
Texas, northern	8	3,202	6,055	52.8	291	7	3,217	5,825	55.2	286
Texas, southern	6	3,561	5,090	69.9	178	6	4,204	5,712	73.6	186
Idaho and Montana	3	836	960	87.0	92	3	768	1,090	70.4	68
Colorado and Wyoming	4	1,282	2,720	47.1	200	4	1,282	2,720	47.1	103
Alaska and Oregon	2	W	W	W	W	2	W	W	W	W
Arizona, Nevada, New Mexico	4	2,114	2,910	72.6	132	4	1,949	3,060	63.7	97
California, northern	3	2,873	3,150	91.2	156	3	3,150	3,175	99.2	99
California, southern	8	7,483	8,833	84.7	318	8	7,796	8,357	93.2	332
Hawaii	1	357	650	54.9	34	1	474	600	79.0	46
Washington	3	753	1,270	59.2	150	2	W	W	W	W
Total or average	126	73,272	98,673	74.3	5,559	122	73,895	98,104	75.3	5,847
Puerto Rico	2	1,385	2,116	65.4	19	2	1,370	2,116	64.7	34

W Withheld to avoid disclosing company proprietary data; included in "Total."

[1] Includes Puerto Rico. Includes data for three white cement facilities as follows: California (1), Pennsylvania (1), and Texas(1). Includes data for grinding plants (9 in 1988 and 8 in 1989) as follows: Alaska (1), Florida (2), Iowa (1), Michigan (1), Pennsylvania (1), Texas (1) in 1988 and (2) in 1989, Utah (1) in 1988, and Washington (1) in 1988.

[2] Includes cement produced from imported clinker (1988—2,339,720 ton, 1989—1,932,281 tons).

[3] Grinding capacity based on fineness necessary to grind Types I and II cement, making allowance for downtime required for maintenance.

[4] Includes imported cement. Source of imports withheld to avoid disclosing company proprietary data.

TABLE 3

CLINKER CAPACITY AND PRODUCTION IN THE UNITED STATES,[1] BY DISTRICT, AS OF DECEMBER 31, 1989

District	Active plants			Total	Number of kilns	Daily capacity (thousand short tons)	Average number of days for maintenance	Apparent annual capacity[2] (thousand short tons)	Production[3] (thousand short tons)	Percent utilized
	Process used									
	Wet	Dry	Both							
New York and Maine	4	1	—	5	6	12	83	3,393	2,780	81.9
Pennsylvania, eastern	2	5	—	7	16	16	56	4,955	4,443	89.6
Pennsylvania, western	3	1	—	4	8	7	69	2,076	1,528	73.6
Maryland	1	2	—	3	7	6	35	1,980	1,834	92.6
Ohio	2	2	—	4	7	7	64	2,112	1,425	67.4
Michigan	2	2	—	4	9	16	57	4,936	4,610	93.3
Indiana	2	2	—	4	8	9	51	2,829	2,525	89.2
Illinois	—	4	—	4	8	8	52	2,509	2,501	99.7
Georgia and Tennessee	1	3	—	4	7	7	30	2,346	1,937	82.5
South Carolina	2	1	—	3	7	8	63	2,417	2,286	94.5
Kentucky, Virginia, West Virginia	1	2	—	3	9	8	68	2,390	2,244	93.9
Florida	2	2	—	4	8	10	16	3,496	2,981	85.2
Nebraska and Wisconsin	—	1	—	1	2	W	54	W	W	W
Alabama	—	5	—	5	6	13	57	4,016	3,456	86.0
Arkansas, Louisiana, Mississippi	3	—	—	3	6	6	54	1,867	1,196	64.0
Utah	1	1	—	2	3	W	59	W	W	W
South Dakota	—	—	1	1	4	W	56	W	W	W
Iowa	—	3	—	3	5	7	50	2,207	2,051	92.9
Missouri	2	3	—	5	7	14	55	4,342	4,306	99.2
Kansas	3	2	—	5	15	7	45	2,246	1,580	70.3
Oklahoma	1	2	—	3	7	6	72	1,758	1,552	88.2
Texas, northern	3	3	—	6	14	13	17	4,536	3,223	71.0
Texas, southern	—	4	1	5	6	14	47	4,458	3,760	84.3
Idaho and Montana	3	—	—	3	4	2	5	835	749	89.7
Colorado and Wyoming	1	3	—	4	6	7	41	2,269	1,152	50.7
Alaska and Oregon	—	1	—	1	1	W	120	W	W	W
Arizona, Nevada, New Mexico	—	4	—	4	11	8	43	2,576	1,770	68.7
California, northern	—	3	—	3	3	10	59	3,067	3,009	98.1
California, southern	1	7	—	8	22	25	33	8,318	7,016	84.3
Hawaii	—	1	—	1	1	1	107	258	240	93.0
Washington	1	1	—	2	2	W	69	W	W	W
Total or average[4]	41	71	2	114	225	263	53	83,151	69,291	83.3
Puerto Rico	2	—	—	2	9	8	101	2,114	1,182	55.9

W Withheld to avoid disclosing company proprietary data; included in "Total."

[1] Includes Puerto Rico and white-cement-producing facilities.

[2] Calculated on individual company data; 365 days, minus average days for maintenance, times the reported 24-hour capacity.

[3] Includes production reported for plants that added or shut down kilns during the year.

[4] Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Consumer demand for cement in the United States, excluding Puerto Rico, declined 2.8% to 90.7 million tons. This was the second year of decline following 5 consecutive years of growth after the 20-year low experienced at the depth of the recession in 1982. According to U.S. Department of Commerce data, housing starts declined 8% to 1.4 million units. The value of new construction put in place declined 1% to $414 billion. The value of residential construction put in place declined 1% to $138 billion, primarily in single-unit structures. The value of nonresidential construction put in place increased 2% to $97 billion. The increases were primarily in industrial buildings, hotels and motels, hospitals, and religious and educational institutions. Public construction experienced the biggest increase, 10%, caused primarily by increases in spending for highways and streets, military facilities, and sewer systems.[1]

Among the consuming States, California continued to lead all areas in the amount of portland cement consumed, followed by, in order of shipments received, Texas, Florida, Illinois, Pennsylvania, and New York. Together, these States consumed 43% of total U.S. tonnage.

Cement shipments increased to four of the nine Census regions. Because of the sustained level of construction activity in southern California, the Pacific region continued to lead all other regions of the country with an 8% increase in consumption. Only marginal increases in consumption of 2% or less were registered in the East North Central, West South Central, and Mountain regions. Shipments to all other regions declined with New England registering a 21% decrease in shipments. The Middle Atlantic suffered a 7% decline in consumption, while the South Atlantic declined 6% and the South East Central region decreased 7%. The West North Central region was down slightly.

Shipments of domestically produced cement from U.S. mills increased slightly; however, the amount of imported cement shipped by producers decreased by 23%. All imported cement shipped by producers and inde-

TABLE 4

DAILY CLINKER CAPACITY IN THE UNITED STATES,[1] DECEMBER 31, 1989

Short tons per 24-hour period	Number		Total capacity (short tons)	Percent of total capacity
	Plants	Kilns[2]		
1988:				
Less than 1,150	15	25	11,548	4.2
1,151 to 1,700	31	55	45,327	16.5
1,701 to 2,300	23	38	44,802	16.3
2,301 to 2,800	16	34	39,760	14.5
2,801 and over	34	90	132,930	48.5
Total	119	242	274,367	100.0
1989:				
Less than 1,150	13	21	10,782	4.0
1,151 to 1,700	30	53	44,156	16.3
1,701 to 2,300	24	41	50,647	18.6
2,301 to 2,800	16	33	39,960	14.7
2,801 and over	33	86	126,139	46.4
Total	116	234	271,684	100.0

[1] Includes Puerto Rico and white-cement-producing facilities.
[2] Total number in operation at plants.

TABLE 5

RAW MATERIALS USED IN PRODUCING PORTLAND CEMENT IN THE UNITED STATES[1]

(Thousand short tons)

Raw materials	1987	1988	1989
Calcareous:			
Limestone (includes aragonite, marble, chalk)	81,143	79,517	81,792
Cement rock (includes marl)	17,959	23,398	21,920
Coral	935	783	911
Other	—	9	13
Argillaceous:			
Clay	4,766	4,784	4,801
Shale	4,906	4,126	4,289
Other (includes staurolite, bauxite, aluminum dross, alumina, volcanic material, other)	263	310	436
Siliceous:			
Sand and calcium silicate	1,873	2,011	1,991
Sandstone, quartzite, other	758	993	605
Ferrous: Iron ore, pyrites, millscale, other iron-bearing material	1,079	1,036	1,026
Other:			
Gypsum and anhydrite	4,939	4,174	4,254
Blast furnace slag	109	86	181
Fly ash	803	940	905
Other, n.e.c.	386	348	356
Total	[2]119,920	122,515	123,480

[1] Includes Puerto Rico.
[2] Data do not add to total shown because of independent rounding.

TABLE 6

MASONRY CEMENT PRODUCTION AND STOCKS IN THE UNITED STATES, BY DISTRICT

District	1988			1989		
	Plants active during year	Production (thousand short tons)	Stocks[1] at mills, Dec. 31 (thousand short tons)	Plants active during year	Production (thousand short tons)	Stocks[1] at mills, Dec. 31 (thousand short tons)
New York and Maine	4	157	16	4	139	15
Pennsylvania, eastern	7	288	36	6	252	40
Pennsylvania, western	4	95	15	4	90	13
Maryland	2	W	W	2	W	W
Ohio	3	133	17	3	129	19
Michigan	4	264	51	4	242	41
Indiana	4	412	57	4	369	67
Illinois	1	W	W	1	W	W
Georgia and Tennessee	4	212	28	4	193	29
South Carolina	2	W	W	2	W	W
Kentucky, Virginia, West Virginia	4	345	23	4	305	19
Florida	4	480	28	4	487	29
Nebraska and Wisconsin	1	W	W	1	W	W
Alabama	7	260	33	5	205	41
Arkansas, Louisiana, Mississippi	2	W	W	2	W	W
Utah	1	W	W	1	W	W
South Dakota	1	3	2	1	W	W
Iowa	2	W	W	2	W	W
Missouri	4	160	9	3	127	8
Kansas	5	48	18	5	45	24
Oklahoma	2	W	W	2	W	W
Texas, northern	6	82	8	5	87	12
Texas, southern	3	51	4	3	55	9
Idaho and Montana	2	W	W	2	W	W
Colorado and Wyoming	2	W	W	2	W	W
Arizona, Nevada, New Mexico	3	70	7	3	56	6
California, northern	—	—	—	—	—	—
California, southern	1	W	W	1	W	W
Hawaii	1	10	1	1	10	1
Washington	1	W	W	—	—	—
Total or average[2]	87	3,595	438	81	3,294	453

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1] Includes imported cement.
[2] Data may not add to totals shown because of independent rounding.

pendent distributors declined for the second consecutive year with imports accounting for 17% of apparent consumption compared with 19% in 1988.

The end-use distribution pattern for portland cement was essentially the same as that of recent years. Ready-mix concrete producers were the primary consumers, accounting for about 74% of the total, followed by concrete product manufacturers with 11%. Smaller amounts were consumed by highway and other contractors; building material dealers; Federal, State, and other government agencies; and a variety of other miscellaneous users.

TRANSPORTATION

The pattern of cement transport did not differ significantly from that of recent years. U.S. shipments of portland cement to consumers were primarily in bulk, 95%; by truck, 90%; and made directly from cement manufacturing plants (rather than from distribution terminals), 61%.

With respect to shipments of cement from plants to terminals, the preferred modes of transportation were railroads, 40%, and waterways, 42%; transportation by truck accounted for 16%. Cement used at producing plants accounted for the remaining 2%.

PRICES

The average mill value of portland cement increased slightly for the first time in 5 years. The increase can be attributed to higher production levels and a reduction of imports. Import prices remained at $48.19 per ton, while domestically produced cement increased slightly to $48.41 per ton. The average value of masonry cement improved slightly to $68.93 per ton compared with $68.25 per ton in 1988. The average value of cement as reported by Engineering News-Record (ENR) declined slightly to $62.52 per ton. The ENR prices are based on an average per ton value of cement delivered to 20 cities. The prices ranged from a low of $42.00 in Dallas, TX, to a high of $78 in New York.[2]

FOREIGN TRADE

According to trade data reported by the U.S. Department of Commerce, Bureau of the Census, cement imported for consumption into the United States and its possessions and territories was 10% lower than in 1988. This was the second year of decline following 3 consecutive years of record-high imports. The decline corresponded to the marginal decrease in total demand resulting from reduced construction activity, primarily in the eastern regions of the United States. Canada, Japan, and Mexico were the principal import

TABLE 7

CLINKER PRODUCED IN THE UNITED STATES,[1] BY FUEL

Fuel	Clinker produced			Fuel consumed		
	Plants active during year	Quantity (thousand short tons)	Percent of total	Coal[2] (thousand short tons)	Oil (thousand 42-gallon barrels)	Natural gas (thousand cubic feet)
1988:						
Coal	17	9,701	13.8	1,762	—	—
Natural gas	3	1,114	1.6	—	—	150,769
Coal and oil	30	21,166	30.1	3,745	383	—
Coal and natural gas	49	26,150	37.1	3,543	—	8,363,116
Oil and natural gas	2	170	.2	—	159	300,726
Coal, oil, natural gas	18	12,139	17.2	1,578	417	2,718,967
Total	119	70,440	100.0	10,628	959	11,533,578
1989:						
Coal	10	7,747	11.0	1,390	—	—
Natural gas	2	563	.8	—	—	102,486
Coal and oil	25	18,103	25.7	3,067	331	—
Coal and natural gas	50	30,248	42.9	4,371	—	7,077,874
Oil and natural gas	4	737	1.0	—	208	295,301
Coal, oil, natural gas	25	13,077	18.6	1,763	681	2,854,863
Total	116	70,475	100.0	10,591	1,220	10,330,524

[1] Includes Puerto Rico.
[2] Includes 1% anthracite, 95% bituminous coal, and 4% petroleum coke in 1988, and 1% anthracite, 98% bituminous coal, and 1% petroleum coke in 1989.

TABLE 8

CLINKER PRODUCED AND FUEL CONSUMED BY THE PORTLAND CEMENT INDUSTRY IN THE UNITED STATES,[1] BY PROCESS

Process	Clinker produced			Fuel consumed		
	Plants active during year	Quantity (thousand short tons)	Percent of total	Coal[2] (thousand short tons)	Oil (thousand 42-gallon barrels)	Natural gas (thousand cubic feet)
1988:						
Wet	46	23,270	33.0	4,326	368	3,899,033
Dry	69	44,940	63.8	5,993	586	7,501,096
Both	4	2,230	3.2	309	5	133,449
Total	119	70,440	100.0	10,628	959	11,533,578
1989:						
Wet	43	22,132	31.4	3,892	708	2,642,033
Dry	71	47,165	66.9	6,509	512	7,627,432
Both	2	1,178	1.7	190	—	61,059
Total	116	70,475	100.0	10,591	1,220	10,330,524

[1] Includes Puerto Rico.
[2] Includes 1% anthracite, 95% bituminous coal, and 4% petroleum coke in 1988, and 1% anthracite, 98% bituminous coal, and 1% petroleum coke in 1989.

sources, accounting for more than 65% of the total. The industry continued to find it more economical to import finished cement instead of clinker for grinding. Clinker accounted for 11% of total imports compared with 32% reached in the peak year 1985. This was the fourth consecutive year that clinker imports declined, reaching its lowest level since 1983. The value of foreign cement delivered to American ports averaged $38 per ton, up 9% from that of 1988, primarily because of increased shipping costs.

Florida led all States in the amount of imports received, accounting for 23% of the total. Sixty two percent, or 2.2 million tons, of the Florida imports was shipped through the Tampa Customs District. Imports made up about 49% of Florida's Portland cement consumption, compared with 17% of consumption nationally. Los Angeles was the second largest recipient of imported cement, receiving 2.2 million tons or 14% of the total.

Exports of hydraulic cement and clinker as reported by the Bureau of the Census increased more than 400% to 512,000 tons. Cement was shipped to 42 countries, with Canada receiving 87% of the total.

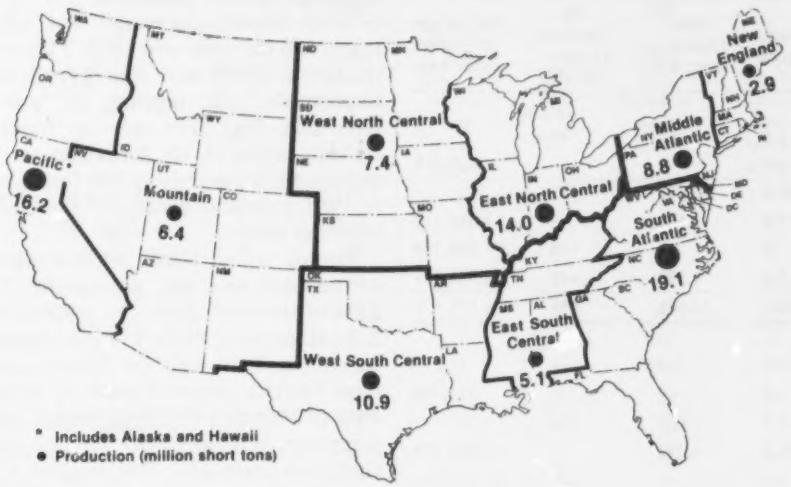
In other trade developments, the International Trade Commission (ITC) was petitioned by cement producers from Arizona, Florida, New Mexico, and Texas alleging that cement from Mexico was being sold in these areas at less than fair value. The ITC conducted a preliminary antidumping investigation and determined that there was a reasonable indication that the industry was materially injured. A final determination was expected to be made by August 1990.

WORLD REVIEW

World cement production was essentially unchanged at 1.2 billion tons. China continued to lead all nations with 18% of production, followed by the U.S.S.R. with 12%, Japan with 7%, and the United States with 6%. Countries with excess capacity continued to export cement to the United States. In 1989, 29 countries exported cement to the United States, essentially the same as in 1988. The amount of

FIGURE 1

SHIPMENTS OF CEMENT BY GEOGRAPHIC REGION OF DESTINATION IN 1989



cement imports declined by 10% because of increased demand within exporting countries and because of a reduction in demand in certain coastal markets of the United States.

There was considerable activity in plant modernization or expansion by industry throughout the world. The international issue of Rock Products magazine describes individual plant activities of the cement-producing nations.[3]

Capacity

The data in table 23 are estimated and were obtained from a number of different sources, including Government representatives, cement associations, producers, consultants and the Cembureau World Cement Directory. Capacity is defined as the maximum quantity of cement that can be produced in a period of time on a normally sustainable basis taking into consideration downtime required for maintenance and repair. Capacity includes operating plants and plants temporarily closed that can be brought into production within a short period of time with minimum capital expenditure.

During 1989, clinker-producing plants

TABLE 9

ELECTRIC ENERGY USED AT PORTLAND CEMENT PLANTS IN THE UNITED STATES,[1] BY PROCESS

Process	Electric energy used						Finished cement produced (thousand short tons)	Average electric energy used per ton of cement produced (kilowatt-hours)
	Generated at portland cement plants		Purchased		Total			
	Active plants	Quantity (million kilowatt-hours)	Active plants	Quantity (million kilowatt-hours)	Quantity (million kilowatt-hours)	Percent		
1988:								
Wet	—	—	44	2,993	2,993	30.1	24,345	122.9
Dry[2]	7	733	72	5,873	6,606	66.4	47,989	137.7
Both	—	—	4	345	345	3.5	2,323	148.5
Total or average	7	733	120	9,211	9,944	100.0	74,657	133.2
Percent of total electric energy used	—	7.4	—	92.6	—	—	—	—
1989:								
Wet	—	—	44	2,823	2,823	28.2	23,018	122.6
Dry[2]	5	807	75	6,190	6,997	70.0	50,983	137.2
Both	—	—	2	176	176	1.8	1,264	139.2
Total or average	5	807	121	9,189	9,996	100.0	75,265	132.8
Percent of total electric energy used	—	8.1	—	91.9	—	—	—	—

[1] Includes Puerto Rico. Includes grinding plants and white cement facilities.
[2] Includes data for grinding plants.

in an estimated 132 countries had a combined annual capacity of about 1.4 billion tons. Of the top 10 producing countries, China led in clinker production capacity, followed by the U.S.S.R., Japan, the United States, India, Brazil, the Federal Republic of Germany, Italy, Spain, and the Republic of Korea. Together these countries control 60% of the world's clinker production capacity.

In the United States, 44% of the clinker production capacity was concentrated in five States: California, Michigan, Missouri, Pennsylvania, and Texas. At yearend, 225 kilns at 114 plants were being operated, excluding Puerto Rico. The average downtime experienced by the industry for maintenance was 53 days, slightly less than in 1988. The average annual kiln capacity increased 2% to 369,560 tons. The average annual plant capacity increased 7% to 729,395 tons as the trend continued toward development of fewer but larger capacity plants.

Australia

Cement demand in Australia continued to flourish with production reaching 7.2 million tons in 1989. Imports from Indonesia, Japan, and The Republic of Korea continued to penetrate the Australian market, prompting the filing of antidumping petitions to curtail imports.

Canada

Canadian cement production declined 2% to 13 million tons. Canada remained the second largest supplier of cement to the United States, supplying markets primarily through ports in 15 custom districts from Anchorage, AK, to St. Albans, VT.

China

China continued to be the world's largest producer of cement. Its production continued to increase at a dramatic rate, reaching an estimated 228 million tons in 1989. Chinese cement is expected to become a bigger player on the international market when several of its plant construction and modernization projects are complete.

Greece

Cement production in Greece as reported to the Bureau of Mines increased slightly following three consecutive years of decline. Greece was the fifth largest supplier of cement to the United States, although the volume of imports declined 38% from that of 1988. The decline was attributed to increased consumption at home, to other European Community countries traditionally served by Greek producers, and to a drop in cement demand in the U.S. eastern seaboard markets.

India

The Indian cement industry continued to aggressively expand its production capacity through new plant construction, modernization, and expansion activities. Cement production in India reached an alltime high of 46 million tons. This was the seventh consecutive year of production growth. India is not a major exporter of cement; however, that situation could change when capacity expansion projects currently in various stages of development are complete.

Japan

Japan continued to maintain its position as the third highest cement producer in the world, producing nearly 90 million tons, or 5% more than in 1988.

TABLE 10

SHIPMENTS OF PORTLAND CEMENT FROM MILLS IN THE UNITED STATES,[1] IN BULK AND IN CONTAINERS, BY TYPE OF CARRIER

(Thousand short tons)

Type of carrier	Shipments from plant to terminal		Shipments to ultimate consumer				Total shipments[2]
			From terminal to consumer		From plant to consumer		
	In bulk	In containers	In bulk	In containers	In bulk	In containers	
1988:							
Railroad	9,496	91	1,479	([3])	3,562	26	5,066
Truck	2,333	335	28,620	731	45,306	3,491	78,148
Barge and boat	9,289	10	2,199	—	334	—	2,533
Unspecified[4]	514	—	419	2	568	18	1,006
Total[2]	21,632	436	32,717	732	49,769	3,535	[5]86,753
1989:							
Railroad	8,915	47	1,525	—	3,041	12	4,579
Truck	3,408	212	27,210	495	44,488	3,260	75,453
Barge and boat	9,392	13	2,879	—	214	—	3,092
Unspecified[4]	517	—	495	9	581	18	1,103
Total[2]	22,232	273	32,109	504	48,324	3,291	[6]84,229

[1] Includes Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.
[3] Less than 1/2 unit.
[4] Includes cement used at plant.
[5] Bulk shipments were 95.1% and container (bag) shipments were 4.9%.
[6] Bulk shipments were 95.5% and container (bag) shipments were 4.5%.

TABLE 11

PORTLAND CEMENT SHIPPED BY PRODUCERS IN THE UNITED STATES, BY DISTRICT[1]

District	1988			1989		
	Quantity (thousand short tons)	Value (thousands)	Average per ton	Quantity (thousand short tons)	Value (thousands)	Average per ton
New York and Maine	3,293	$168,033	$51.02	2,999	$153,319	$51.13
Pennsylvania, eastern	4,800	258,807	53.91	4,259	230,506	54.12
Pennsylvania, western	1,509	70,827	46.93	1,498	71,474	47.70
Maryland	1,808	89,083	49.27	1,871	94,002	50.25
Ohio	1,424	70,816	49.73	1,446	73,230	50.64
Michigan	5,253	231,141	44.00	5,449	253,324	46.49
Indiana	2,315	107,179	46.29	2,364	108,297	45.81
Illinois	2,307	101,760	44.10	2,776	117,224	42.23
Georgia and Tennessee	2,307	114,455	49.61	2,072	100,818	48.66
South Carolina	2,533	118,670	46.84	2,188	99,083	45.28
Kentucky, Virginia, West Virginia	2,463	117,482	47.69	2,288	114,077	49.86
Florida	3,682	168,719	45.82	4,357	207,857	47.71
Nebraska and Wisconsin	W	W	W	W	W	W
Alabama	3,524	157,214	44.61	3,169	130,590	41.21
Arkansas, Louisiana, Mississippi	1,698	68,590	40.39	1,234	48,414	39.24
Utah	771	39,664	51.44	W	W	W
South Dakota	W	W	W	W	W	W
Iowa	2,029	98,930	48.75	2,072	102,387	49.42
Missouri	4,679	184,755	39.48	4,922	182,005	36.98
Kansas	1,569	72,805	46.40	1,505	69,390	46.12
Oklahoma	1,432	42,131	29.42	1,236	39,360	31.85
Texas, northern	3,270	162,816	49.79	3,293	155,937	47.36
Texas, southern	3,730	129,440	34.70	3,907	130,300	33.35
Idaho and Montana	719	39,638	55.12	657	38,366	58.36
Colorado and Wyoming	1,258	60,327	47.95	1,392	56,066	40.26
Alaska and Oregon	W	W	W	W	W	W
Arizona, Nevada, New Mexico	2,325	136,045	58.51	2,234	130,749	58.53
California, northern	3,076	177,733	57.78	3,127	184,543	59.02
California, southern	7,347	423,419	57.63	7,784	457,476	58.77
Hawaii	354	28,880	81.58	493	40,495	82.17
Washington	979	48,233	49.26	W	W	W
Total[2 3] or average	74,074	3,575,906	48.27	74,202	3,592,252	48.41
Foreign imports[4]	r11,712	542,942	r46.36	8,653	416,988	48.19
Puerto Rico	1,397	113,966	81.57	1,374	112,318	81.77
Grand total[3 5] or average	r87,183	4,232,814	r48.55	84,229	4,121,558	48.93

W Withheld to avoid disclosing company proprietary data; included in "Total."

[1] Includes Puerto Rico. Includes data for three white cement facilities as follows: California (1), Pennsylvania (1), and Texas (1). Includes data for grinding plants (9 in 1988 and 8 in 1989) as follows: Alaska (1), Florida (2), Iowa (1), Michigan (1), Pennsylvania (1), Texas (1) in 1988 and (2) in 1989, Utah (1) in 1988, and Washington (1) in 1988.

[2] Includes cement produced from imported clinker.

[3] Data may not add to totals shown because of independent rounding.

[4] Cement imported and distributed by domestic producers only.

[5] Does not include cement consumed at plant.

TABLE 12

MASONRY CEMENT SHIPPED BY PRODUCERS IN THE UNITED STATES,[1] BY DISTRICT

District	1988			1989		
	Quantity (thousand short tons)	Value (thousands)	Average per ton	Quantity (thousand short tons)	Value (thousands)	Average per ton
New York and Maine	171	$9,966	$58.28	155	$8,925	$57.74
Pennsylvania, eastern	296	21,065	71.16	254	18,577	73.22
Pennsylvania, western	95	7,648	80.50	95	7,895	82.78
Maryland	W	W	W	W	W	W
Ohio	129	11,140	86.35	128	11,233	88.07
Michigan	265	22,915	86.47	255	22,286	87.50
Indiana	405	27,442	67.75	357	24,054	67.36
Illinois	W	W	W	W	W	W
Georgia and Tennessee	213	14,620	68.63	193	13,307	68.98
South Carolina	W	W	W	W	W	W
Kentucky, Virginia, West Virginia	338	22,093	65.36	289	19,463	67.25
Florida	411	25,892	62.99	477	31,231	65.54
Nebraska and Wisconsin	W	W	W	W	W	W
Alabama	273	16,457	60.28	252	13,852	54.99
Arkansas, Louisiana, Mississippi	W	W	W	W	W	W
Utah	W	W	W	W	W	W
South Dakota	W	W	W	W	W	W
Iowa	W	W	W	W	W	W
Missouri	153	6,310	41.24	123	6,193	50.39
Kansas	50	2,988	59.76	42	2,514	59.44
Oklahoma	W	W	W	W	W	W
Texas, northern	81	7,216	89.08	79	7,010	88.95
Texas, southern	55	3,584	65.16	54	3,725	69.16
Idaho and Montana	W	W	W	W	W	W
Colorado and Wyoming	W	W	W	W	W	W
Alaska and Oregon	W	W	W	W	W	W
Arizona, Nevada, New Mexico	71	5,468	77.01	57	4,545	79.61
California, northern	—	—	—	—	—	—
California, southern	W	W	W	W	W	W
Hawaii	10	1,531	153.10	10	1,566	160.00
Washington	W	W	W	—	—	—
Total[2] or average	3,574	243,941	68.25	3,329	229,441	68.93
Foreign imports[3]	100	7,674	76.74	54	4,250	78.19
Grand total[2] or average	3,674	251,615	68.48	3,383	233,691	69.08

W Withheld to avoid disclosing company proprietary data; included in "Total."

[1] Does not include quantities produced on the job by masons.

[2] Data may not add to totals shown because of independent rounding.

[3] Cement imported and distributed by domestic producers only. Source of imports withheld to avoid disclosing company proprietary data.

TABLE 13

CEMENT SHIPMENTS, BY DESTINATION AND ORIGIN[1]

(Thousand short tons)

Destination and origin	Portland cement[2]			Masonry cement		
	1987	1988	1989	1987	1988	1989
Destination:						
Alabama	1,405	1,423	1,266	137	122	107
Alaska[3]	94	r95	111	—	W	—
Arizona	2,299	2,131	2,090	W	W	W
Arkansas	766	690	765	43	37	36
California, northern	3,598	3,958	4,190	W	W	W
California, southern	8,121	8,584	8,851	W	W	W
Colorado	1,110	992	1,082	16	13	12
Connecticut[3]	1,029	990	775	24	24	19
Delaware[3]	254	277	268	15	15	12
District of Columbia[3]	146	198	195	1	1	(4)
Florida	6,819	7,002	7,181	531	561	556
Georgia	3,321	3,170	2,666	248	238	197
Hawaii	329	355	493	10	10	1
Idaho	251	324	305	(4)	(4)	(4)
Illinois	1,498	1,278	1,259	30	30	28
Chicago, metropolitan[3]	2,037	2,294	2,421	66	69	69
Indiana	1,704	1,773	1,865	103	108	98
Iowa	1,199	1,225	1,262	12	12	12
Kansas	1,351	1,147	1,094	25	21	18
Kentucky	1,201	1,138	1,100	92	91	83
Louisiana	1,761	1,527	1,621	43	36	34
Maine	361	366	319	12	15	9
Maryland	1,645	1,722	1,518	156	171	136
Massachusetts[3]	1,589	1,439	1,090	51	49	38
Michigan	2,740	2,720	2,717	146	152	141
Minnesota[3]	1,582	1,464	1,588	51	48	42
Mississippi	787	760	705	53	48	43
Missouri	2,091	2,165	1,971	53	48	48
Montana	175	199	172	1	1	1
Nebraska	720	749	829	10	10	10
Nevada	754	1,081	1,256	(4)	(4)	(4)
New Hampshire[3]	345	337	272	15	15	11
New Jersey[3]	1,932	r1,973	1,813	88	83	72
New Mexico	517	507	522	8	6	6
New York, eastern	746	638	637	46	42	36
New York, western	989	1,070	1,036	57	55	55
New York, metropolitan[3]	1,851	r1,622	1,539	55	52	49
North Carolina[3]	2,145	2,179	1,959	283	281	241
North Dakota[3]	278	223	208	4	4	3
Ohio	3,314	3,439	3,451	189	205	184
Oklahoma	1,076	1,061	1,017	34	28	29
Oregon	728	799	844	(4)	(4)	1
Pennsylvania, eastern	2,132	2,446	2,251	87	99	89
Pennsylvania, western	1,350	1,215	1,100	82	79	75
Rhode Island[3]	244	215	189	6	7	6
South Carolina	1,138	1,213	1,109	152	151	126
South Dakota	272	275	289	5	4	5

See footnotes at end of table.

TABLE 13—Continued

CEMENT SHIPMENTS, BY DESTINATION AND ORIGIN[1]

(Thousand short tons)

Destination and origin	Portland cement[2]			Masonry cement		
	1987	1988	1989	1987	1988	1989
Destination—Continued						
Tennessee	1,863	1,698	1,621	203	185	161
Texas, northern	3,799	3,270	3,273	96	87	77
Texas, southern	4,267	3,940	4,017	69	66	75
Utah	804	620	741	1	1	2
Vermont[3]	173	209	172	6	6	7
Virginia	2,557	2,604	2,349	225	241	221
Washington	r1,476	r1,660	1,698	8	r7	8
West Virginia	455	375	361	31	30	29
Wisconsin	1,587	1,635	1,752	46	47	46
Wyoming	317	257	227	1	1	1
U.S. total[5]	r89,092	r88,719	87,472	3,727	3,711	3,374
Foreign countries[6]	185	184	230	114	33	101
Puerto Rico	1,296	1,397	1,379	—	—	—
Total shipments[5]	r90,573	r90,300	89,081	3,841	3,744	3,475
Origin:						
United States[7]	74,868	73,743	74,155	3,715	3,468	3,190
Puerto Rico	1,296	1,397	1,379	—	—	—
Foreign:[8]						
Domestic producers	r10,595	r11,712	8,653	60	r211	264
Others	3,814	3,448	4,894	67	66	22
Total shipments[5]	r90,573	r90,300	89,081	3,841	r3,745	3,475

W Withheld to avoid disclosing company proprietary data; included with "Foreign countries."

[1] Includes cement produced from imported clinker and imported cement shipped by domestic producers, Canadian cement manufacturers, and other importers. Includes Puerto Rico.

[2] Excludes cement (1987—305,000 tons, 1988—318,000 tons, and 1989—183,935 tons) used in the manufacture of prepared masonry cement.

[3] Has no cement-producing plants.

[4] Less than 1/2 unit.

[5] Data may not add to totals shown because of independent rounding.

[6] Direct shipments by producers to foreign countries and U.S. possessions and territories; includes States indicated by symbol W.

[7] Includes cement produced from imported clinker by domestic producers.

[8] Imported cement distributed by domestic producers, Canadian cement manufacturers, and other importers. Origin of imports withheld to avoid disclosing company proprietary data.

Japanese exports to the United States increased 37% to 2.4 million tons in 1989. Of Japanese exports to the United States, 67% was shipped to the Los Angeles area.

Korea, Republic of

The Republic of Korea's cement production increased 49% during the past 5 years to 34 million tons in 1989. Internal cement consumption in Republic of Korea has increased steadily, reducing the amount of production available for export. Korean exports to the United States declined 59% in 1989, and further declines were expected. Exports to the United States were shipped primarily to the Los Angeles area.

Mexico

Cement production in Mexico continued to grow, reaching about 26 million tons in 1989. Mexico was again the biggest supplier of cement to the United States, accounting for 28% of total imports. Eighteen of the 36 customs districts reported receiving Mexican cement. The Tampa, FL, Customs District was the largest recipient of Mexican cement with 1.2 million tons, or 28% of the total.

CURRENT RESEARCH

The Bureau of Mines concluded research on the use of lightweight concrete for ground support in underground mining. The objective of the research was to develop concepts for new, innovative continuous liners and other support systems for metal and nonmetal underground mines having soft, caving, and squeezing ground conditions. Field and laboratory tests demonstrated the feasibility of using lightweight concrete in lining systems. The innovative concepts developed by this research will aid mine operators by decreasing capital and maintenance costs and by improving productivity in soft, caving, squeezing or bursting ground conditions found in deep mines.[4]

The Construction Technology Laboratories (CTL) of the Portland Cement Association reported development of a new concrete using lightweight aggregates. According to CTL, the new concrete is lighter and has better insulating properties than conventional concretes. Unit weights can range from 120

pounds per cubic foot (pcf) to as low as 20 pcf, compared with 140 pcf to 150 pcf for normal weight concretes. CTL also claims that the product offers a broad range of compressive strengths and thermal and fire resistances. The materials are particularly suited for constructing high- and-low-rise buildings, bridges, religious facilities, sports arenas, floor slabs, roof decks, and fire barriers.[5]

OUTLOOK

The demand for cement in 1990 is expected to remain essentially unchanged from 1989, driven primarily by continued weakness in the multifamily residential and nonresidential building construction markets. Gradual increases in demand are anticipated after 1990 as the economy improves. The Portland Cement Association estimates that cement demand will reach 100 million and 101 million tons by 1994 and 1995, respectively.[6]

There has been considerable attention given to repairing or rebuilding the Nation's infrastructure. These cement consumption forecasts could be altered dramatically depending on the level of spending authorized for this undertaking.

Imports will continue to be a significant source of supply. The trend toward increased world consumption of cement, however, could impact the amount of cement available for export to U.S. markets, particularly given the political and economic changes taking place in Eastern Europe.

Cement prices could benefit from a restricted supply of foreign cement. The price of foreign cement will also rise as water freight rates continue to increase and as more complaints are filed by domestic producers alleging that the industry is being injured by dumping.

BACKGROUND

The science of making cement is ages old. During construction of the Great Pyramid about 2600 B.C., the Egyptians made cementing material by calcining impure gypsum containing calcium carbonate. The Greeks were probably the first to calcine limestone for mortar, about 185 B.C. Portland cement was first produced and patented by Joseph Aspdin in 1824. The name "portland" was chosen because the set cement resembles a building stone quarried from the Isle of Portland off the southern coast of England. The first cement plant in the United States was built in Pennsylvania where David O. Saylor obtained a patent for creating a cement equal to the portland cement made in England.

Definitions, Grades, and Specifications

Section 4 of the Annual Book of the American Society for Testing and Materials (ASTM) publishes standards, test methods, definitions, recommended practices, classifications, and specifications for cement, lime, and gypsum.[7] The National Institute for

TABLE 14

CEMENT SHIPMENTS,[1] BY REGION AND SUBREGION

Region and subregion[2]	Portland cement				Masonry cement			
	Thousand short tons		Percent of grand total		Thousand short tons		Percent of grand total	
	1988	1989	1988	1989	1988	1989	1988	1989
Northeast:								
New England	3,556	2,818	4	3	115	89	3	3
Middle Atlantic	9,005	8,377	10	10	411	376	11	11
Total[3]	12,561	11,194	14	13	526	465	14	14
South:								
Atlantic	18,740	17,606	21	20	1,645	1,518	44	45
East Central	5,019	4,692	6	6	431	394	12	12
West Central	10,488	10,692	12	12	255	251	7	7
Total[3]	34,247	32,990	39	38	2,331	2,164	63	64
Midwest:								
East	13,139	13,465	15	15	669	565	18	17
West	7,248	7,241	8	8	147	139	4	4
Total[3]	20,387	20,706	23	23	816	704	22	21
West:								
Mountain	6,112	6,396	7	7	22	22	1	1
Pacific	r15,451	16,187	17	19	r17	18	—	—
Total[4]	r21,563	22,583	24	26	38	40	1	1
Grand total[3]	r88,759	87,472	100	100	r3,712	3,374	100	100

[1] Includes imported cement shipped to importers.
[2] Geographic regions as designated by the U.S. Department of Commerce, Bureau of the Census.
[3] Data may not add to totals shown because of independent rounding.
[4] Does not include proprietary data from table 13.

TABLE 15

PORTLAND CEMENT SHIPMENTS IN 1989, BY DISTRICT OF ORIGIN AND TYPE OF CUSTOMER[1]

District of origin	Building material dealers		Concrete product manufacturers		Ready-mixed concrete		Highway contractors		Other contractors		Federal, State and other government agencies		Miscellaneous including own use		Total[2] (thousand short tons)
	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	Quantity (thousand short tons)	Percent	
New York and Maine	190	6.3	432	14.4	2,151	71.6	123	4.1	88	2.9	(3)	0.1	17	0.6	3,002
Pennsylvania, eastern	358	8.4	913	21.4	2,661	62.5	193	4.5	34	.8	42	1.0	59	1.4	4,259
Pennsylvania, western	171	11.4	248	16.5	934	62.3	110	7.3	36	2.4	—	—	(3)	.1	1,498
Maryland	99	5.3	354	18.9	1,329	71.0	31	1.6	46	2.5	—	—	14	.7	1,872
Ohio	49	3.4	202	14.0	1,152	79.7	41	2.8	1	.1	(3)	—	1	—	1,446
Michigan	191	3.5	684	12.5	4,100	75.4	357	6.5	84	1.5	8	.1	25	.5	5,449
Indiana	124	5.3	301	12.7	1,762	74.5	161	6.8	—	—	—	—	17	.7	2,365
Illinois	12	.4	162	5.8	2,358	84.9	219	7.9	24	.9	—	—	(3)	.1	2,776
Georgia and Tennessee	123	5.9	376	18.1	1,400	67.5	79	3.8	87	4.2	(3)	.1	8	.4	2,073
South Carolina	55	2.5	414	18.9	1,518	69.3	96	4.4	36	1.7	22	1.0	48	2.2	2,189
Kentucky, Virginia, West Virginia	77	3.4	309	13.5	1,657	72.4	127	5.5	119	5.2	—	—	—	—	2,288
Florida	440	10.0	630	14.4	2,918	66.5	143	3.2	127	2.9	3	.1	129	2.9	4,389
Nebraska and Wisconsin	W	W	W	W	W	W	W	W	W	W	—	—	W	W	W
Alabama	212	6.7	452	14.3	2,041	64.3	157	4.9	85	2.7	4	.1	221	7.0	3,172
Arkansas, Louisiana, Mississippi	39	3.2	119	9.7	762	61.7	124	10.1	129	10.4	9	.7	52	4.2	1,234
Utah	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
South Dakota	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Iowa	48	2.3	384	18.5	1,361	65.7	236	11.4	12	.6	5	.2	27	1.3	2,072
Missouri	70	1.4	229	4.7	3,998	81.2	362	7.4	134	2.7	—	—	129	2.6	4,922
Kansas	82	5.4	92	6.1	1,135	75.4	119	7.9	28	1.9	1	—	49	3.3	1,505
Oklahoma	54	4.3	85	6.9	710	57.4	120	9.8	214	17.3	(3)	—	53	4.3	1,236
Texas, northern	182	5.5	281	8.5	1,719	52.2	194	5.9	483	14.7	75	2.3	359	10.9	3,294
Texas, southern	151	3.8	358	9.2	2,808	71.9	196	5.0	164	4.2	11	.3	219	5.6	3,907
Idaho and Montana	14	2.1	71	10.7	421	64.0	42	6.4	76	11.6	(3)	—	34	5.2	658
Colorado and Wyoming	68	4.9	143	10.3	848	60.9	233	16.7	87	6.3	(3)	—	13	.9	1,393
Alaska and Oregon	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Arizona, Nevada, New Mexico	71	3.2	382	17.1	1,387	62.1	21	.9	362	16.2	7	.3	4	.2	2,234
California, northern	176	5.6	391	12.5	2,486	79.5	23	.7	38	1.2	(3)	.1	12	.4	3,127
California, southern	258	3.3	1,109	14.2	5,903	75.8	9	.1	348	4.5	5	.1	159	2.0	7,791
Hawaii	30	6.1	65	13.2	364	73.8	5	1.1	16	3.3	7	1.4	5	1.1	493
Washington	W	W	W	W	W	W	W	W	W	W	—	—	W	W	W
Foreign Imports[4]	—	—	—	—	8,608	99.5	—	—	—	—	—	—	45	.5	8,653
Total[2] or average	3,475	4.2	9,436	11.4	60,914	73.5	3,943	4.8	3,030	3.6	202	.2	1,909	2.3	82,909
Puerto Rico	607	44.2	92	6.7	643	46.8	—	—	27	1.9	5	.4	(3)	—	1,374

W Withheld to avoid disclosing company proprietary date; included in "Total."

[1] Includes Puerto Rico.

[2] Data may not add to totals shown because of independent rounding.

[3] Less than 1/2 unit.

[4] Cement imported and distributed by domestic producers only. Source of imports withheld to avoid disclosing company proprietary data.

TABLE 16

PORTLAND CEMENT SHIPPED FROM PLANTS IN THE UNITED STATES,[1] BY TYPE

	1988			1989		
	Quantity (thousand short tons)	Value[2] (thousands)	Average per ton	Quantity (thousand short tons)	Value[2] (thousands)	Average per ton
General use and moderate heat (Types I and II)	79,943	$3,826,576	$47.87	77,597	$3,718,291	$47.92
High-early-strength (Type III)	3,359	178,149	53.04	3,133	164,291	52.45
Sulfate-resisting (Type V)	697	36,600	52.51	758	43,970	58.03
Oil well	916	48,193	52.61	869	42,316	48.70
White	365	61,155	167.54	456	70,715	155.24
Portland slag and portland pozzolan	625	33,454	53.52	545	29,618	54.33
Expansive	64	5,595	87.42	40	3,999	100.62
Miscellaneous[3]	769	43,092	56.03	832	48,358	58.10
Total[4 5] or average	86,738	4,232,814	48.80	84,229	4,121,558	48.93

[1] Includes Puerto Rico.
[2] Mill value is the actual value of sales to customers, f.o.b. plant, less all discounts and allowances, less all freight charges to customer, less all freight charges from producing plant to distribution terminal if any, less total cost of operating terminal if any, less cost of paper bags and pallets.
[3] Includes waterproof, low-heat (Type IV), and regulated fast-setting cement.
[4] Data may not add to totals shown because of independent rounding.
[5] Does not include cement consumed at plant.

Standards and Technology establishes and the General Services Administration issues Federal specifications for hydraulic cements used in Federal construction projects. Following is a brief discussion of various types of hydraulic cements and the materials from which they are made.

Clinker.—Clinker is produced by heating a properly proportioned mixture of finely ground raw materials containing calcium carbonate, silica, alumina, and iron oxide in a kiln to a temperature of about 2,700° F at which partial fusion occurs. The fused material, which ranges from fine sand grains to walnut size, is ground with small amounts, 3% to 5%, of calcium sulfate, usually gypsum or anhydrite, to make portland cement.

Portland Cement.—ASTM specifications C-150 covers five types of portland cement: (1) Type I, for use when special properties specified for other types are not required, (2) Type II, for general use, more especially when moderate sulfate resistance or moderate heat of hydration is desired, (3) Type III, for use when high early strength is required, (4) Type IV, for use when a low heat of hydration is desired, and (5) Type V, for use when high sulfate resistance is required. ASTM specifications also include Type IA, Type IIA,

TABLE 17

AVERAGE MILL VALUE, IN BULK, OF CEMENT IN THE UNITED STATES[1]

(Per short ton)

Year	Portland cement	Prepared masonry cement[2]	All classes of cement
1985	51.30	66.64	51.87
1986	50.10	65.68	50.73
1987	r48.79	70.55	r49.70
1988	r48.55	68.48	r49.36
1989	48.93	69.08	49.71

r Revised
[1] Includes Puerto Rico. Mill value is the actual value of sales to customers, f.o.b. plant, less all discounts and allowances, less all freight charges from producing plant to distribution terminal if any, less total cost of operating terminal if any, less cost of paper bags and pallets.
[2] Masonry cement made at cement plants only.

TABLE 18

U.S. EXPORTS OF HYDRAULIC CEMENT AND CEMENT CLINKER, BY COUNTRY

(Thousand short tons and thousand dollars)

Country	1987		1988		1989	
	Quantity	Value	Quantity	Value	Quantity	Value
Bahamas	1	58	2	161	8	747
Canada	45	7,025	91	6,381	447	18,609
Ghana	2	130	2	133	14	1,018
Mexico	3	1,355	4	1,164	27	2,120
Netherlands	(1)	73	(1)	31	1	139
Other[2]	r1	r922	r2	r1,037	15	2,928
Total	52	9,563	101	8,907	512	25,561

r Revised.
[1] Less than 1/2 unit.
[2] Includes 38 countries in 1987; 27 in 1988; and 37 in 1989.

Source: Bureau of the Census.

TABLE 19

U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER, BY COUNTRY

(Thousand short tons and thousand dollars)

Country	1987			1988			1989		
	Quantity	Value		Quantity	Value		Quantity	Value	
		Customs	C.i.f.[1]		Customs	C.i.f.[1]		Customs	C.i.f.[1]
Canada	4,154	146,693	157,606	3,628	139,968	143,889	3,420	132,558	142,733
Colombia	612	14,914	22,090	647	16,798	23,924	849	23,594	34,122
France	772	15,152	24,373	758	27,085	34,473	355	18,909	28,646
Greece	1,641	36,559	49,141	2,271	62,450	78,470	1,403	41,945	55,948
Japan	723	18,351	25,108	1,758	46,719	57,619	2,415	62,239	78,622
Korea, Republic of	616	14,241	18,095	520	11,326	14,521	211	5,808	7,440
Mexico	4,960	125,666	156,585	4,992	124,527	149,885	4,411	118,468	146,452
Spain	3,044	80,745	106,996	1,857	54,463	68,860	1,562	47,218	62,010
Venezuela	766	17,534	24,498	641	16,530	22,484	755	22,205	30,149
Other	438	18,677	22,096	416	15,857	21,982	360	16,579	19,203
Total	17,726	488,532	606,588	17,488	515,723	616,107	15,741	489,523	605,325

[1] Cost, insurance, and freight.

Source: Bureau of the Census.

TABLE 20

U.S. IMPORTS FOR CONSUMPTION OF CLINKER, BY COUNTRY

(Thousand short tons and thousand dollars)

Country	1987			1988			1989		
	Quantity	Value		Quantity	Value		Quantity	Value	
		Customs	C.i.f.[1]		Customs	C.i.f.[1]		Customs	C.i.f.[1]
Canada	846	25,056	28,150	417	12,943	14,163	407	13,063	14,459
Colombia	58	1,265	1,515	39	946	1,235	82	2,012	3,037
France	342	7,839	9,818	402	11,801	15,006	185	8,991	10,949
Greece	343	6,330	8,272	53	1,098	1,101	43	1,155	1,569
Japan	37	883	1,222	137	3,030	4,281	235	5,462	7,598
Mexico	1,215	21,114	26,241	437	8,363	10,415	423	10,511	13,647
Spain	734	14,121	17,543	344	8,282	10,889	254	5,469	7,251
Other	93	2,765	2,941	90	2,163	3,007	116	3,351	4,018
Total	3,668	79,373	95,702	1,919	48,626	60,097	1,745	50,014	62,528

[1] Cost, insurance, and freight.

Source: Bureau of the Census.

and Type IIIA for the same uses, but with the addition of air entraining compounds to protect concrete against freeze-thaw damage.

White Cement.—White cement is made from iron-free materials of exceptional purity, usually limestone, china clay or kaolin, and silica. The clinker is burned with a reducing flame in the kiln and rapidly quenched in a water-spray to keep any iron in the ferrous state to avoid coloration by ferric ions. The clinker is then ground with high-purity white gypsum using ceramic balls and liners in grinding mills. White cement is used in decorative concrete, including terrazzo, highway lane markers, and architectural concrete.

Masonry Cement.—Masonry cement is a hydraulic cement used in mortars for masonry construction. It contains one or more of the following materials: portland cement, portland-pozzolan cement, slag cement, or hydraulic lime, usually with hydrated lime, limestone, chalk, calcareous shale, talc, slag, or clay interground for plasticity. ASTM designation C-91 contains specifications for masonry cement.

ASTM designation C-595 covers the following four kinds of blended hydraulic cements, each with an optional provision for air entraining.

Portland-Blast Furnace Slag.—This is essentially an intimately interground mixture of portland cement clinker and granulated blast furnace slag, or an intimate and uniform blend of portland cement and fine granulated blast

TABLE 21

U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER, BY CUSTOMS DISTRICT AND COUNTRY

(Thousand short tons and thousand dollars)

Customs district and country	1988			1989		
	Quantity	Value		Quantity	Value	
		Customs	C.i.f.[1]		Customs	C.i.f.[1]
Anchorage:						
Canada	8	654	953	12	717	976
Japan	37	990	1,218	65	2,378	3,194
Total	45	1,644	2,171	77	3,095	4,170
Baltimore:						
Canada	22	595	644	64	1,710	1,864
Colombia	—	—	—	94	2,763	2,988
Greece	169	4,084	4,470	81	2,251	2,447
Japan	(2)	45	57	(2)	62	80
Mexico	131	2,585	3,129	160	4,066	4,454
Netherlands	(2)	104	113	(2)	59	63
Spain	82	2,138	2,315	23	675	860
Venezuela	6	150	163	—	—	—
Total[3]	411	9,701	10,892	422	11,586	12,757
Boston:						
Canada	6	145	149	42	1,178	1,235
Colombia	6	157	302	10	285	303
Greece	336	12,465	13,351	220	7,147	7,329
Mexico	—	—	—	24	669	682
Netherlands	(2)	11	14	—	—	—
Spain	54	2,960	3,351	30	790	800
United Kingdom	15	736	746	—	—	—
Venezuela	—	—	—	7	286	296
Total[3]	417	16,474	17,912	333	10,355	10,647
Buffalo:						
Canada	1,017	45,139	45,139	925	41,564	43,692
United Kingdom	(2)	4	4	—	—	—
Total[3]	1,017	45,142	45,142	925	41,564	43,692
Charleston:						
France	—	—	—	(2)	19	24
Germany, Federal Republic of	(2)	3	3	—	—	—
Mexico	46	978	1,260	75	2,176	3,205
Netherlands	(2)	6	6	—	—	—
Spain	108	2,363	2,984	43	1,090	1,392
Total[3]	154	3,351	4,254	118	3,285	4,623
Chicago:						
Canada	(2)	3	3	—	—	—
Belgium	—	—	—	(2)	2	6
Japan	(2)	29	33	(2)	26	34
Lebanon	24	781	1,315	—	—	—
Total[3]	24	813	1,349	(2)	28	40
Cleveland: Canada	135	4,735	5,901	138	4,673	6,284
Columbia-Snake: Japan	125	2,911	3,878	116	2,872	3,861

See footnotes at end of table.

TABLE 21—Continued

U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER, BY CUSTOMS DISTRICT AND COUNTRY

(Thousand short tons and thousand dollars)

Customs district and country	1988			1989		
	Quantity	Value		Quantity	Value	
		Customs	C.i.f.[1]		Customs	C.i.f.[1]
Detroit:						
Canada	650	25,283	26,570	550	21,572	23,266
Germany, Federal Republic of	(2)	6	7	—	—	—
Netherlands	(2)	23	27	—	—	—
Turkey	—	—	—	20	783	783
Venezuela	—	—	—	19	770	866
Total[3]	650	25,312	26,604	589	23,125	24,915
Duluth: Canada	144	4,449	4,995	80	2,083	2,458
El Paso: Mexico	450	16,961	16,961	496	18,011	20,022
Great Falls:						
Canada	(2)	2	2	(2)	12	12
Yugoslavia	(2)	13	13	—	—	—
Total[3]	(2)	15	15	(2)	12	12
Honolulu:						
Colombia	—	—	—	30	529	1,148
Japan	137	3,030	4,281	195	4,524	6,319
Korea, Republic of	12	461	643	—	—	—
Mexico	—	—	—	33	788	1,436
Total[3]	149	3,491	4,923	258	5,841	8,902
Houston-Galveston:						
Denmark	—	—	—	(2)	6	6
Germany, Federal Republic of	(2)	24	28	(2)	32	41
Italy	(2)	3	5	—	—	—
Mexico	317	6,323	8,882	54	1,079	1,403
Spain	62	1,525	2,131	11	711	711
Total[3]	378	7,875	11,046	66	1,828	2,161
Laredo:						
China	—	—	—	1	136	161
Mexico	229	8,155	8,223	144	5,894	6,531
Panama	1	31	31	—	—	—
Total[3]	229	8,186	8,254	145	6,030	6,692
Los Angeles:						
Denmark	18	571	1,533	4	181	469
France	(2)	973	1,232	(2)	40	44
Japan	1,158	32,044	37,847	1,607	41,629	50,115
Korea, Republic of	508	10,865	13,878	134	3,833	5,052
Spain	23	822	974	214	6,738	8,650
Sri Lanka (Ceylon)	—	—	—	20	585	716
Taiwan	115	2,783	3,720	76	1,848	2,470
Turkey	—	—	—	33	753	1,300
United Kingdom	—	—	—	29	750	1,001
Venezuela	—	—	—	46	1,811	2,148
Yugoslavia	1	91	136	(2)	56	62
Total[3]	1,823	48,149	59,322	2,162	58,224	72,028

See footnotes at end of table.

TABLE 21—Continued

U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER, BY CUSTOMS DISTRICT AND COUNTRY

(Thousand short tons and thousand dollars)

Customs district and country	1988			1989		
	Quantity	Value		Quantity	Value	
		Customs	C.i.f.[1]		Customs	C.i.f.[1]
Miami:						
Belgium-Luxembourg	3	188	284	2	184	340
Brazil	(2)	2	2	—	—	—
Colombia	12	355	447	60	1,917	2,344
Denmark	6	372	452	11	656	839
France	—	—	—	(2)	13	14
Germany, Federal Republic of	(2)	5	7	—	—	—
Greece	505	12,499	16,276	180	5,255	9,131
Mexico	449	9,102	12,954	591	13,073	19,652
Spain	296	10,786	13,420	328	13,587	14,724
Sweden	4	148	170	—	—	—
Venezuela	128	3,200	4,210	187	5,047	6,779
Total[3]	1,404	36,657	48,220	1,360	39,732	53,823
Mobile:						
Greece	52	1,098	1,101	—	—	—
Mexico	334	5,232	6,789	—	—	—
Total	386	6,330	7,890	—	—	—
New Orleans:						
Belgium-Luxembourg	—	—	—	(2)	42	46
Canada	26	865	1,040	—	—	—
France	293	8,982	11,354	206	6,146	8,332
Mexico	300	6,034	10,223	124	2,696	4,490
Spain	439	10,484	13,555	75	2,439	3,071
Total[3]	1,059	26,364	36,172	405	11,323	15,940
New York City:						
Belgium	—	—	—	(2)	54	65
Colombia	—	—	—	14	287	443
France	119	3,303	4,605	—	—	—
Greece	743	19,727	26,251	611	18,677	25,138
Mexico	161	3,222	4,865	14	313	391
Saudi Arabia	36	613	1,076	—	—	—
Spain	208	6,952	8,718	344	10,224	13,937
Sweden	35	1,042	1,397	—	—	—
Switzerland	(2)	2	2	—	—	—
United Kingdom	5	145	210	(2)	1	1
Total[3]	1,308	35,004	47,123	985	29,556	39,976
Nogales: Mexico	418	9,915	9,915	416	10,434	11,806
Norfolk:						
Bahamas	6	217	268	3	96	149
Colombia	34	902	1,317	129	3,866	5,501
France	51	7,801	9,206	75	9,925	18,194
Germany, Federal Republic of	(2)	15	19	—	—	—
Greece	141	4,503	5,545	25	731	975
Mexico	38	1,060	1,500	91	1,978	3,289
Netherlands	(2)	1	1	—	—	—
Spain	52	1,509	1,960	—	—	—

See footnotes at end of table.

TABLE 21—Continued

U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER, BY CUSTOMS DISTRICT AND COUNTRY

(Thousand short tons and thousand dollars)

Customs district and country	1988			1989		
	Quantity	Value		Quantity	Value	
		Customs	C.i.f.[1]		Customs	C.i.f.[1]
Norfolk—Continued						
United Kingdom	6	242	309	1	442	506
Venezuela	156	4,283	6,526	180	5,330	8,233
Total[3]	486	20,533	26,652	506	22,368	36,846
Ogdensburg:						
Canada	279	9,089	9,089	316	10,531	11,181
Netherlands	—	—	—	(2)	12	14
Total	279	9,089	9,089	316	10,543	11,195
Pembina: Canada	190	8,780	8,780	253	10,962	12,037
Philadelphia:						
France	41	1,124	1,528	—	—	—
Germany, Federal Republic of	(2)	112	123	(2)	8	11
Greece	104	2,271	3,605	156	4,062	6,180
Spain	202	5,825	7,634	224	7,292	9,613
Total[3]	347	9,332	12,890	380	11,362	15,804
Portland, ME:						
Canada	14	697	697	16	723	772
Mexico	2	64	64	—	—	—
Portugal	20	777	942	—	—	—
Total[3]	36	1,538	1,704	16	723	772
Providence:						
Canada	—	—	—	5	135	146
Colombia	131	3,262	5,961	118	2,900	7,219
Greece	119	3,145	4,254	113	3,319	4,093
Spain	62	1,654	2,412	8	237	351
Venezuela	5	186	246	—	—	—
Total[3]	317	8,247	12,872	243	6,591	11,810
St. Albans:						
Canada	567	17,502	17,504	467	15,484	17,415
France	—	—	—	(2)	130	135
Netherlands	(2)	62	72	(2)	12	14
Total[3]	567	17,564	17,576	468	15,626	17,564
San Diego:						
Japan	25	737	909	—	—	—
Mexico	661	22,942	23,595	627	21,049	22,685
Morocco	(2)	4	4	—	—	—
Total	686	23,683	24,508	627	21,049	22,685
San Francisco:						
Japan	39	1,221	1,605	160	4,229	5,732
Korea, Republic of	—	—	—	77	1,975	2,388
Mexico	271	7,066	7,781	290	7,724	8,173
Yugoslavia	(2)	4	7	(2)	7	12
Total[3]	313	8,290	9,393	527	13,935	16,305

See footnotes at end of table.

TABLE 21—Continued

U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER, BY CUSTOMS DISTRICT AND COUNTRY

(Thousand short tons and thousand dollars)

Customs district and country	1988			1989		
	Quantity	Value		Quantity	Value	
		Customs	C.i.f.[1]		Customs	C.i.f.[1]
San Juan, PR:						
Belgium-Luxembourg	7	461	787	7	499	854
Canada	—	—	—	(2)	11	15
Colombia	39	946	1,235	49	1,224	1,602
Denmark	13	1,069	1,424	10	626	1,064
Germany, Federal Republic of	—	—	—	(2)	10	19
Honduras	32	853	1,303	56	1,581	2,051
Ireland	—	—	—	(2)	10	18
Italy	(2)	2	3	—	—	—
Japan	(2)	5	5	(2)	9	9
Mexico	31	832	1,123	1	34	62
Venezuela	—	—	—	(2)	2	4
Total[3]	122	4,168	5,881	122	4,006	5,698
Savannah:						
Colombia	9	258	273	30	903	910
Mexico	30	688	728	18	506	506
Spain	48	1,749	1,844	—	—	—
United Kingdom	—	—	—	(2)	1	2
Venezuela	—	—	—	8	249	249
Total[3]	88	2,695	2,846	56	1,659	1,668
Seattle:						
Canada	569	22,026	22,417	552	21,042	21,405
China	—	—	—	(2)	19	22
Colombia	(2)	3	3	—	—	—
Japan	237	5,708	7,787	271	6,503	9,267
Yugoslavia	(2)	5	9	—	—	—
Total[3]	806	27,742	30,215	823	27,564	30,695
Tampa:						
Bahamas	—	—	—	3	104	124
Belgium	—	—	—	(2)	73	96
Colombia	331	8,693	11,210	283	7,683	10,163
Denmark	59	W	W	66	W	W
France	253	W	W	73	W	W
Greece	101	2,657	3,617	—	—	—
Mexico	1,121	23,367	31,893	1,227	27,628	36,838
Spain	221	5,696	7,561	263	6,096	7,899
Sweden	5	202	237	—	—	—
Venezuela	286	7,657	10,250	282	7,913	10,675
Total[3]	2,376	57,073	76,234	2,197	56,043	72,979
Virgin Islands of the United States:						
Bahamas	1	35	37	—	—	—
Barbados	1	73	94	(2)	11	11
Canada	2	4	5	—	—	—
Colombia	2	171	179	28	978	1,216
Dominican Republic	—	—	—	15	427	433
Japan	—	—	—	1	8	10

See footnotes at end of table.

TABLE 21—Continued

U.S. IMPORTS FOR CONSUMPTION OF HYDRAULIC CEMENT AND CLINKER, BY CUSTOMS DISTRICT AND COUNTRY

(Thousand short tons and thousand dollars)

Customs district and country	1988			1989		
	Quantity	Value		Quantity	Value	
		Customs	C.i.f.[1]		Customs	C.i.f.[1]
Virgin Islands of the United States—Continued						
Leeward and Windward Islands	(2)	8	10	(2)	34	35
Sweden	3	114	116	—	—	—
Trinidad and Tobago	—	—	—	1	38	40
Venezuela	60	1,054	1,089	25	796	899
Total[3]	68	1,459	1,530	71	2,292	2,644
Wilmington, NC:						
Colombia	79	2,051	2,998	—	—	—
Germany, Federal Republic of	—	—	—	(2)	24	24
Greece	—	—	—	17	503	656
Mexico	—	—	—	28	616	1,132
Total	79	2,051	2,998	45	1,143	1,812
Grand Total[3]	17,488	515,723	616,107	15,741	489,523	605,325

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1] Cost, insurance, and freight.
[2] Less than 1/2 unit.
[3] Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

TABLE 22

U.S. IMPORTS FOR CONSUMPTION OF CEMENT AND CLINKER

(Thousand short tons and thousand dollars)

Year	Roman, portland, other hydraulic cement		Hydraulic cement clinker		White nonstaining portland cement		Total[1]	
	Quantity	Value (customs)	Quantity	Value (customs)	Quantity	Value (customs)	Quantity	Value (customs)
1985	9,581	306,472	4,633	103,067	274	27,890	14,487	437,429
1986	12,086	361,149	3,972	79,699	261	28,145	16,319	468,993
1987	13,782	384,989	3,668	79,373	276	24,170	17,726	488,532
1988	15,225	438,978	1,919	48,626	344	28,119	17,488	515,723
1989	13,601	410,326	1,745	50,014	395	29,183	15,741	489,523

[1] Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

furnace slag in which the slag constituent ranges between 25% to 70% of the total weight of the cement.

Portland-Pozzolan Cement.—Portland-pozzolan cement is produced by intergrinding portland cement clinker and pozzolan, by blending portland cement or portland-blast furnace slag cement and finely divided pozzolan, or a combination of intergrinding and blending in which the amount of the pozzolan is between 15% and 40% of the total weight of the cement.

Pozzolan-Modified Portland Cement.—The constituents in this type of cement are the same as those for portland-pozzolan cement, and the methods of production are also the same. However, pozzolan makes up less than 15% of the total weight of the blended cement.

Slag Cement.—Slag cement is a finely divided material made from a uniform blend of granulated blast furnace slag and hydrated lime. The slag constitutes at least 70% of the total weight of the blended cement.

Pozzolan.—Pozzolan is a siliceous and aluminous material that in itself possesses little or no cementitious value but will, in a finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties. Fly ash is a pozzolanic material obtained from flue gases produced by coal combustion. Natural pozzolans are naturally occurring materials such as diatomaceous earths, opaline cherts and shales, tuffs, volcanic ash, and pumicites. ASTM C-618 covers fly ash and natural pozzolans.

Oil-Well Cement.—Oil-well cement was developed to seal oil and gas wells under pressures up to 1,800 pounds per square inch and temperatures up to 350° F. This cement must remain fluid up to about 4 hours to be effective.

Expansive Cement.—Expansive cement is a hydraulic cement that tends to increase in volume after setting during the early hardening period. There are three types of expansive cements, Types K, M, and S. Expansive cements are used primarily in shrinkage-compensating concrete. ASTM specification C-845 covers all expansive cements.

TABLE 23

WORLD CEMENT ANNUAL PRODUCTION CAPACITY, DECEMBER 31, 1989[1]

(Million short tons)

Country	Rated clinker capacity[e,1]
North America:	
Canada	16
Mexico	27
United States (including Puerto Rico)	85
Total	128
South America:	
Argentina	12
Brazil	47
Venezuela	7
Other	20
Total	86
Europe:	
Belgium	8
Czechoslovakia	10
France	26
German Democratic Republic	14
Germany, Federal Republic of	44
Greece	17
Italy	44
Poland	21
Portugal	8
Romania	20
Spain	39
Turkey	25
U.S.S.R.	154
United Kingdom	17
Yugoslavia	12
Other	101
Total	560
Africa:	
Algeria	12
Egypt	22
South Africa, Republic of	12
Other	34
Total	80
Asia:	
China	220
India	56
Indonesia	20
Japan	97
Korea, North	11
Korea, Republic of	34
Thailand	12
Taiwan	24

See footnotes at end of table.

TABLE 23—Continued

WORLD CEMENT ANNUAL PRODUCTION CAPACITY, DECEMBER 31, 1989[1]

(Million short tons)

Country	Rated clinker capacity[e,1]
Asia—Continued	
Other	35
Total	509
Oceania:	
Australia	9
Other	2
Total	11
World total	1,374

[e] Estimated.

[1] Includes capacities of operating plants as well as plants on standby basis.

Aluminous Cement.—Sometimes known as calcium aluminate cement, high alumina cement, or "Ciment Foundu," aluminous cement is a hydraulic nonportland cement. Special applications of aluminous cement are based on its rapid hardening qualities, resistance to sulfate action, and refractory properties when used as "castable refractories" and mortars for furnaces and kilns.

Concrete.—Concrete is a proportioned mixture of coarse mineral aggregates of sand and gravel or crushed stone, bound together by a paste of hydraulic cement and water. Volume 04.02 of ASTM standards covers concrete and aggregates.

Products for Trade and Industry

Portland cement composes 96% of the total domestic output; the remainder is mostly masonry cement. About 92% of total portland cement production in 1989 comprised Type I and II cement, 4% was Type III, and 1% was oil-well cement. Cements produced in quantities comprising less than 1% each were portland-pozzolan and portland-blast furnace slag, Type IV, Type V, white, expansive, and waterproof cements. A small quantity of regulated set cement was produced. Each product requires either a change in proportion of raw materials mixed for kiln feed or additives to the clinker.

Industry Structure

The industry is composed of 130 cement producing plants in 40 States. Multi-plant operations were being run by 23 companies. Because of overall poor financial performance by the industry during the 1980's, many companies have left the cement business or closed plants and began importing finished cement or clinker for grinding into finish cement. Fifteen independent importers have constructed terminals to receive foreign cement for markets near coastal areas. The industry has also undergone dramatic changes in ownership. At yearend, foreign investors controlled approximately 65% of U.S. production capacity.

Resources

Primary raw materials required for cement clinker production are, in order of importance, limestone, clay and shale, and iron ore. In instances where essential chemical components are not present in the primary raw material in the required amount, other mined materials or industrial products may be used as additives to correct these deficiencies. Gypsum is added during the clinker grinding process to make finished portland cement.

Although raw materials for cement manufacturing have not been quantified, they are abundant in most countries. Some countries deficient in raw materials meet their requirement by importing. Many domestic companies have reported reserves of raw materials exceeding 100 years supply.

Technology

Principal steps in manufacturing portland cement consist of crushing, grinding, mixing, and burning raw materials and grinding the resultant clinker. About 1.8 tons of raw materials is required to make 1 ton of cement.

Raw Material Grinding.—Both dry and wet grinding are used to obtain a fineness that may range from 75% to 90% passing through a 200-mesh sieve. In wet-milling, water is added with the mill feed to produce a slurry containing about 65% solids. The raw material is then dried and ground for burning.

Burning.—Burning is the most important operation in manufacturing cement because fuel consumption is a

TABLE 24

HYDRAULIC CEMENT: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand short tons)

Country[2]	1985	1986	1987	1988[p]	1989[e]
Afghanistan[e]	85	95	110	110	110
Albania[e]	940	940	945	880	880
Algeria[e]	6,720	7,120	7,170	7,170	7,170
Angola[e]	390	390	390	r1,100	1,100
Argentina	5,104	6,122	6,947	6,667	4,927
Australia	6,489	6,534	6,469	7,055	7,165
Austria	5,027	5,036	4,985	5,250	5,290
Bahamas	—	(3)	—	—	—
Bangladesh[4]	265	322	342	397	413
Barbados	e240	219	226	203	237
Belgium	6,103	6,349	6,271	7,111	7,600
Benin[e]	331	331	331	r550	550
Bolivia	418	r325	437	499	5557
Brazil	22,721	27,885	28,076	27,919	27,560
Bulgaria	5,828	6,285	6,056	6,101	6,100
Burma	526	478	429	342	5414
Canada	11,235	11,687	13,892	13,268	13,000
Chile	1,570	1,580	1,757	2,021	1,900
China[e]	157,100	178,000	198,000	224,000	228,000
Colombia	r5,916	r6,626	6,575	7,031	6,900
Congo	64	e64	442	e64	64
Costa Rica	524	573	613	613	600
Cote D'Ivoire (Ivory Coast)	748	855	719	770	770
Cuba	3,508	3,643	3,897	3,931	4,100
Cyprus	727	952	941	956	950
Czechoslovakia	11,315	11,352	11,430	12,097	512,002
Denmark	1,917	2,237	2,080	1,853	2,200
Dominican Republic	1,110	1,175	e1,200	1,647	1,700
Ecuador	2,167	2,221	1,765	2,200	2,200
Egypt	6,337	8,391	9,641	10,789	10,700
El Salvador	496	488	669	687	5697
Ethiopia[e]	275	275	275	275	275
Fiji	103	102	—	—	—
Finland	1,773	1,567	1,572	1,658	1,650
France	25,955	e25,900	25,970	e26,500	26,500
Gabon	270	232	151	145	155
German Democratic Republic	12,795	13,214	13,702	13,790	13,800
Germany, Federal Republic of	28,393	29,299	27,853	28,897	29,200
Ghana	400	241	302	526	5623
Greece	15,067	14,706	14,515	14,388	14,400
Guadeloupe	190	199	e210	220	220
Guatemala	580	710	1,459	1,660	51,779
Haiti	291	278	278	276	240
Honduras	383	r397	497	617	660
Hong Kong	2,023	2,465	2,454	2,413	2,400
Hungary	4,054	4,239	4,578	4,269	4,300

See footnotes at end of table.

TABLE 24—Continued

HYDRAULIC CEMENT: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand short tons)

Country[2]	1985	1986	1987	1988[p]	1989[e]
Iceland	126	125	144	[e]148	130
India	36,409	40,124	40,763	44,900	[5]46,407
Indonesia	11,112	12,060	13,055	13,495	[5]15,541
Iran	13,739	13,529	14,031	13,450	13,800
Iraq[e]	8,500	8,800	11,000	11,600	13,800
Ireland	1,606	1,541	1,596	1,857	1,800
Israel	2,227	2,270	2,454	2,564	2,500
Italy	40,429	[r]39,615	41,069	[e]40,800	40,200
Jamaica	264	266	337	409	400
Japan	80,300	78,555	78,871	85,489	89,600
Jordan	2,230	1,978	[e]2,500	2,015	[5]1,962
Kenya	934	1,446	1,456	1,366	[5]1,341
Korea, North[e]	8,800	8,800	9,900	11,000	11,000
Korea, Republic of	22,514	25,797	28,287	31,961	[5]33,592
Kuwait	1,315	1,118	[e]1,120	979	990
Lebanon[e]	1,100	1,000	1,000	1,000	1,000
Liberia	105	107	116	117	[5]94
Libya	[e]7,200	2,289	2,976	[e]3,000	3,000
Luxembourg	325	429	561	621	610
Madagascar[e]	39	39	39	39	39
Malawi	68	77	80	72	77
Malaysia	3,448	[r]3,934	3,655	4,161	[5]5,284
Mali[e]	[5]21	22	24	28	28
Martinique[e]	220	220	220	220	220
Mauritania	—	—	88	99	[5]99
Mexico	22,796	21,772	24,633	24,816	25,900
Mongolia[e]	[5]166	[r]470	[r]600	[r]660	660
Morocco	4,072	4,125	[e]4,200	[e]4,200	4,200
Mozambique[e]	[r]220	[r]220	[r]280	[r]440	440
Nepal	35	102	167	237	290
Netherlands	3,209	3,417	[e]3,440	3,400	3,900
New Caledonia[e]	66	44	55	66	66
New Zealand	1,069	999	970	[e]990	1,050
Nicaragua[e]	110	110	110	110	110
Niger[e]	42	42	44	[5]29	30
Nigeria	3,680	4,255	4,189	3,748	3,860
Norway	1,764	1,929	1,807	1,574	[5]1,516
Oman	715	[e]770	926	869	[5]1,044
Pakistan[e]	5,765	5,760	7,530	[5]7,761	7,700
Panama	336	370	[e]385	[e]385	385
Paraguay	51	197	288	354	360
Peru	1,937	2,432	2,849	[e]2,800	2,200
Philippines	3,395	3,910	3,660	4,700	4,400
Poland	16,535	17,416	17,747	[r e]18,740	16,500
Portugal	5,913	6,001	[e]6,400	6,300	6,600
Qatar	350	340	[e]330	[r e]330	330
Romania	13,490	15,670	15,760	[e]15,400	15,400
Saudi Arabia	[r]9,062	[r]10,287	9,474	[e]10,500	10,500

See footnotes at end of table.

major expense, plant capacity is measured by kiln output, and strength and other properties of cement depend on the quality of the clinker. Burning takes place in a rotary kiln that is a refractory-lined steel cylindrical shell. It rotates on an axis inclined at ⅜ to ½ inch per foot toward the discharge end. U.S. kilns range in size from 116 to 760 feet long and 8 to 24 feet in diameter.

Byproducts and Coproducts

There are no major byproducts and coproducts in manufacturing hydraulic cement in the U.S. Flotation, a method of beneficiation used by some companies to remove undesirable constituents from raw materials to increase the calcium carbonate content of the kiln feed, produces waste such as silica sand, or mica fines which may be marketed. Waste rock quarried in selective mining of usable raw material has been sold for riprap and fill materials or crushed and sold as aggregate for concrete or for road base. Some kiln dusts with high alkali content have been collected and used as fertilizer or processed to recover potash.

Economic Factors

Prices.—Cement prices are greatly influenced by local or regional markets and the availability of energy and raw materials required for cement manufacturing. Discounts for cash and large quantity purchases, absorption of freight charges, and the cost of paper bags and pallets add to the complexity of cement price patterns. Extreme competition among producers and stiff competition from imports are primary contributors to depressed prices, which severely limit investment dollars available for capital improvement or expansion.

Costs.—Cement production costs are determined by such factors as plant location, plant age and level of modernization, type of production process used, the availability of raw materials, and labor. Energy represents by far the largest portion of production costs, accounting for 40% of the total. The industry has had considerable success in stabilizing production costs by undertaking modernization projects that not only conserve energy but increase production capacity.

TABLE 24—Continued

HYDRAULIC CEMENT: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand short tons)

Country[2]	1985	1986	1987	1988[p]	1989[e]
Senegal	449	397	410	431	[5]419
Singapore	2,195	1,989	1,684	1,759	[5]1,881
South Africa, Republic of	7,754	[r]7,399	7,424	9,354	9,600
Spain (including Canary Islands)[e]	[5][6]26,673	26,500	25,800	26,500	27,000
Sri Lanka[e]	660	660	660	440	440
Sudan	213	[r e]165	134	[r e]165	165
Suriname[e]	55	55	55	55	55
Sweden	2,341	2,336	2,467	2,425	2,425
Switzerland	4,689	4,842	5,089	5,473	[5]6,020
Syria	4,736	4,630	4,266	3,671	[5]3,859
Taiwan	15,893	16,321	17,226	19,049	[5]19,889
Tanzania[e]	330	330	330	330	330
Thailand	8,726	8,723	10,931	12,692	[5]16,561
Togo	313	384	407	416	[5]429
Trinidad and Tobago	362	[r]360	357	397	420
Tunisia	3,372	3,289	[e]3,750	[e]5,500	5,500
Turkey	19,380	22,050	24,228	24,995	[5]26,235
Uganda	[e]22	[r e]17	12	10	11
U.S.S.R.	144,096	148,943	151,462	153,771	154,300
United Arab Emirates	[r e]4,635	[r e]3,780	3,644	3,897	3,970
United Kingdom	14,704	14,785	[e]14,770	15,983	15,400
United States (including Puerto Rico)	78,859	79,916	79,501	78,252	[5]78,559
Uruguay	346	375	442	479	[5]513
Venezuela	5,836	6,335	6,735	6,833	[5]4,971
Vietnam[e]	1,430	1,700	1,667	1,650	1,760
Yemen (Sanaa)	1,543	1,279	838	712	770
Yugoslavia	9,952	10,061	9,880	9,744	9,400
Zaire	489	490	542	[r e]500	500
Zambia	349	368	413	446	[5]425
Zimbabwe	[e]770	[e]825	894	855	[5]793
Total	[r]1,057,794	[r]1,106,182	1,153,425	1,215,498	1,235,613

[e] Estimated. [p] Preliminary. [r] Revised.

[1] Table includes data available through June 27, 1990.

[2] In addition to the countries listed, Cameroon produces cement, but available information is inadequate to make reliable estimates of output levels.

[3] Less than 1/2 unit.

[4] Data are for the year ending June 30 of that stated.

[5] Reported figure.

[6] Excludes natural cement.

Tariffs.—For countries with most-favored-nation status, duties are imposed only on white cement in the amount of 22 cent per ton, including the weight of containers. Other hydraulic cement and clinker are duty free. The statutory import duty for countries without most-favored-nation status is $1.76 per ton and $1.32 per ton for all other types of cement and clinker, respectively.

Operating Factors

Environmental Requirements.—Since the 1970's, the U.S. cement industry has been required to make substantial capital investments to comply with environmental restrictions. The biggest source of pollution associated with cement production is controlling dust from kilns and clinker coolers. That requires the installation of dust collectors such as bag houses and electrostatic precipitators, both of which add considerably to operating costs without improving production. In addition to meeting air quality standards, the industry must also comply with water quality, land use, health and safety, and noise requirements. It has been estimated that capital costs for meeting these requirements can account for 20% to 25% of the capital expenditures for new plants and major additions.[8]

Employment.—In the U.S. cement industry in 1989, there were approximately 19,900 workers, including individuals employed in mining and milling operations. Employment in the industry has continued to decline primarily because automated process control technology permits greater productivity with fewer employees.

Energy Requirements.—The U.S. cement industry is one of the largest users of energy, consuming about 275 trillion Btu's during 1989. Substantial energy savings have been achieved since the Federal Government implemented the voluntary energy conservation program in 1972. The installation of improved raw material grinding and processing technology, the use of preheater-precalciner systems for burning raw material, the conversion from wet to dry process, and the conversion from oil and gas to coal for kiln firing all contributed to improved energy efficiency. Further improvements in energy consumption will result as technological and institutional barriers to the use of municipal, industrial, and hazardous wastes for kiln firing are removed.

[1] U.S. Department of Commerce, International Trade Administration. Construction Review. V. 36, No. 2, Mar.-Apr. 1990, pp. 1-10.

[2] Engineering News-Record. ENR Materials Prices. V. 224, No. 1, Jan. 1990, pp. 73-74.

[3] Cement International. Rock Products. V. 93, No. 4, Apr. 1990, pp. 59-87.

[4] Skinner, E. H. Structural Uses and Placement Techniques for Concrete in Underground Mining. BuMines RI 9266, 1989, pp. 1-31.

[5] Construction Technology Laboratories Inc. CTL Review. V. 13, No. 1, Apr. 1990, pp. 1-4.

[6] Portland Cement Association. Market and Economic Research. U.S. Cement Consumption Forecast. May 1990, pp. 1-19.

[7] American Society for Testing and Materials. S. 4, v. 04.01, Cement, Lime, and Gypsum. Apr. 1, 1988, pp. 1-544.

[8]U.S. Department of Commerce, International Trade Administration. A Competitive Assessment of the U.S. Cement Industry. July 1987, pp. 144–146.

OTHER SOURCES OF INFORMATION

Bureau of Mines Publications

Cement. Ch. in Mineral Commodity Summaries, annual.
Cement. Ch. in Minerals Yearbook, annual.
Cement. Reported monthly in Mineral Industry Surveys.

Other Sources

Pit and Quarry.
International Cement Review.
Cembureau, World Cement Directory.